Crack Offset Measurement With the Projected Laser Target Device

Defect/Damage Location

The device and associated analysis methodology summarized in this report were developed for the purpose of estimating the size of discontinuities in the surface of the foam that covers the Space Shuttle External Tank. These surface offsets are thought to be due to subsurface cracks in the foam insulation. The mathematical analysis and procedure described here provide a method to quantity the dimensions of the crack offset in a direction perpendicular to the surface, making use of the projected laser target device (PLTD) tool and a laser line projector.

The keys to the construction and use of the PLTD are the following geometrical design requirements:

- Laser dots are on a square grid: length α on a side.
- Laser beams are perpendicular to projected surface.
- Beams are parallel out to the distance being projected.

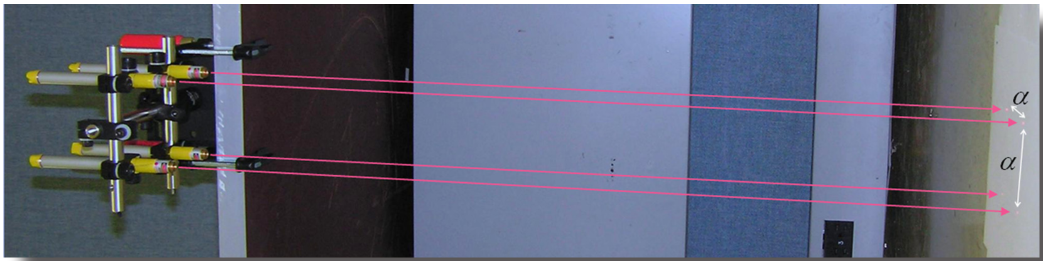

Figure 1. The projected laser target device (PLTD).

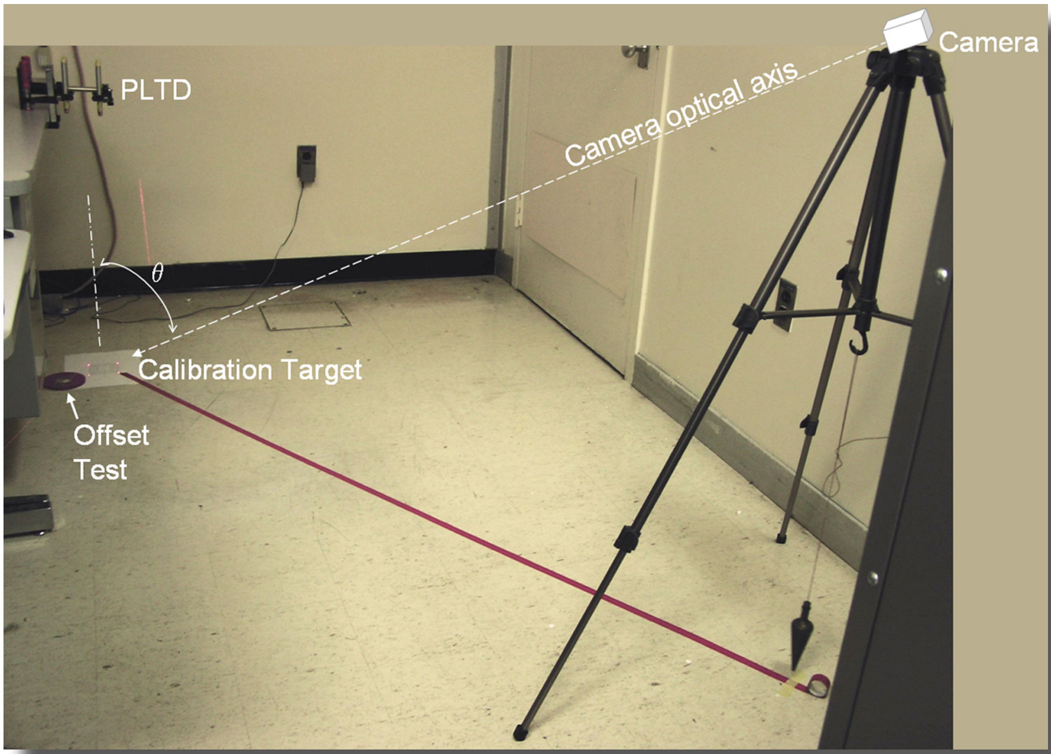

Figure 2. Test setup, with a camera, PLTD, and a laser line projector.

The PLTD can be used to (1) calibrate fixed cameras of unknown magnification and orientation (far-field solution); (2) provide equivalent calibration to multiple cameras, previously achieved only by the use of known target points, for example, in 3-D foreign-object debris tracking on a fixed launch platform; (3) compute scaling for conventional 2-D images, and depth of field for 3-D images (near-field solution); and (4) in conjunction with a laser line projector, achieve accurate measurements of surface discontinuity (cracks) in a direction perpendicular to the surface.

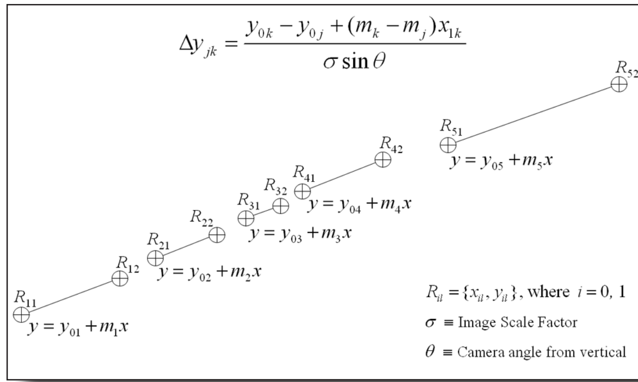

Figure 5. Data extracted from image analysis (Figure 4) for offset measurement.

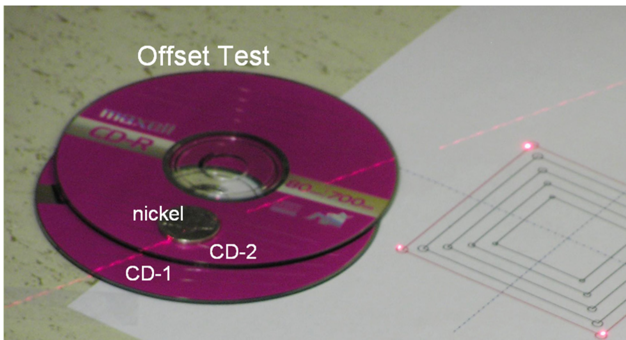

Figure 3. Setup for measuring vertical offset of test objects.

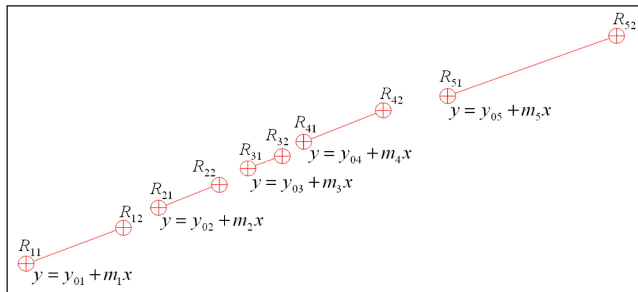

Figure 6. Analysis of data from Figure 5.

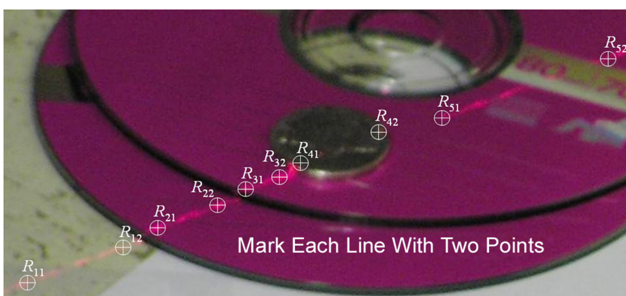

Figure 4. Image analysis of test in Figure 3.

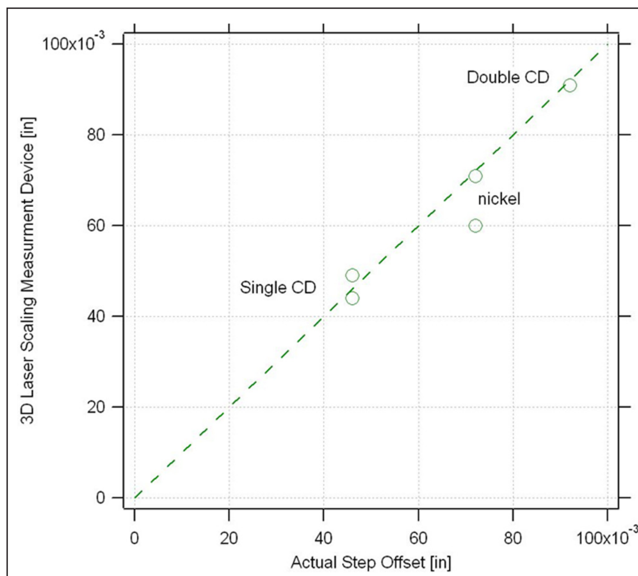

Figure 7. Plot of test data, showing measured offsets compared to actual offsets.

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